Assessment of Design Qualities of Transmission Main and Access Road on Cost and Construction Completion of Water Supply Projects

(Case of Gundo-Meskel Town Water Supply Project, Oromia)

By

Mengistu Zewde Gonfa

A project Submitted in Partial Fulfillment of the Requirements for the Degree of Masters of Engineering in Hydraulic Engineering of Addis Ababa science and Technology University

Addis Ababa science and Technology University

January, 2017

CERTIFICATION

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Date defended: ……

Approved by Board of Examiners:

1. _____ _____

   Examiner Signature

2. _____ _____

   Chairman, Graduate Committee Signature

3. _____ _____

   College Dean Signature

4. _____ _____

   Department Head Signature

ABSTRACT

Economic design is one of the most determining factors for the implementation of almost all structures in general and social infrastructure projects in particular. So poor design of social infrastructures is one of the 'must meet' factors that would lead to delayance of construction completion and economic construction of the projects. The objective of this project is to assess that the determining factors behind the cost increment and construction completion time delayance of Gundo meskel town water supply project.

Gundo Meskel town is located in North Shewa Zone, Dera Woreda, which is about 220 KM from the regional capital, Finfinne, and 110 KM from the Zonal capital, Fitche, along the main Finfinne-Bahirdar asphalt road up to Dagam town and the gravel road which detached and then 86Km all-weather road which runs to Gundo Meskel town. The geographic location of the project area is 10013'44" North and 38042'01" East.

Currently people living in the project area are facing acute shortage of water because of a poor and inadequate water supply system of the Town. To overcome the effects of this acute water shortage, the government of Oromia Regional state through its Water, Mineral And Energy Bureau had made an agreement with local contractor on the 8th of March, 2013 G.C. with the original construction price of 32,016476.66 ETB including VAT with intended completion date for the whole of the works shall be 540 calendar days from the signing of the agreement (contract agreement of the Gundo meskel water supply project, 2013 G.C). However, the project is not completed yet (28th of January, 2017 G.C)! And the construction price of the project is also raised to 43,075,732.35ETB (grand total with VAT). So, in this assessment, the selected route for transmission main and access road was not feasible for the following two reasons:

1. The access road selected was not feasible in terms of cost compared to the total cost of the project (increased from 9,192,363ETB to 87,927,681.50ETB,

2 .the transmission main cannot be constructed unless and otherwise the access road is constructed

So in order to handle the problem wisely, the route for the transmission main and access road was decided to be changed so that the construction cost of the road would be maintained to the original value and that of the transmission main is subjected to tolerable increment(323,48ETB to 6,624,80ETB).

ACKNOWLEDGEMENT

First and foremost, thanks to the Almighty God for granting me His limitless care, love and blessings all along the way.

I would like to express my gratitude to my sponsor Ethiopian Roads Authority for giving me the chance to continue my M.E. education by covering all my expenses.

I am deeply indebted to Addis Ababa science and Technology University, School of Architecture and Civil Engineering staffs for their excellent guidance, encouragement, and unlimited support they provided me throughout my project. I would like to thank them once again for their friendly approach, for devoting their valuable time with me in discussing the project work and for providing me all the necessary materials.

Last but not least, I would like to thank my family and my friends who were spiritually with me, and gave me the strength to finalize my duties successfully.

Mengistu Zewde

ACRONYMS

ADD	Average day demand
BH	Borehole
CSA	Central Statistics Authority
DCI	Ductile Cast Iron
DN	Nominal Diameter
E.C.	Ethiopian Calendar
EEPCO	Ethiopian Electric Power Corporation
HC	House Connection
HDPE	High Density Polyethylene
i.e.	That is
KV	Kilovolt
KW	Kilowatt
L/S	Littre per Second
M3/hr.	Meter cube per hour
M3/s	Meter cube per second
MoWR	Ministry of Water Resource
MWE	Ministry of Water and Energy
NPSH	Net Positive Suction Head
PE	Polyethylene
PF	Public fountain
RUPI	Regional urban planning institute
TOR	Terms of Reference
OWMEB	Oromia water, mines and energy bureau

UPVC	UN Plasticized Polyvinyl Chloride
YC	Yard Connection

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1. INTRODUCTION

Water is one of the most necessities for the existence of living things in general and human beings in particular. Urbanization all over the country is growing rapidly, accordingly providing improved urban infrastructures is among the government's short term and long term plans. Adequate and potable water supply facilities are one of these basic infrastructures. Lack of potable water supply results in high social and economic problems, but most of the timely provision of adequate and potable water supply demands high amount of capital investment that resulted in major challenges for many towns in providing their increasing populations with adequate and potable water supply. As a result, the demand for adequate water supply for industrial, commercial and domestic purposes continues to rise while the financial and technical capacities of most towns is limited resulting in increased competitions for this limited resources.

Thus, the Oromia National Regional State, in its effort to change the backward economic and social status of the region and providing basic necessities for the citizens of the region, is undertaking development of urban infrastructures with the assistance of development partners, donors and international financial institutions. One of such program is the water supply and sanitation undertaken by the regional Water, Mineral and Energy Bureau to improve the water supply and sanitation system of selected urban and rural areas of the region. As stated in the Terms of Reference the Government of Oromia has allocated funds from his own sources to support its regional Water Supply, Sanitation and Hygiene Program. The Urban Water Supply, Sanitation and Hygiene component of the program is to finance planning and improvements to water supply and sanitation service in the regional towns by supporting capacity building through participating water boards/ committees and operators to effectively manage their water supply and sanitation facilities, and to ensure that well-functioning and properly utilized urban water supply systems and improved sanitation are in place in participating towns.

Gundo Meskel town, as per the Terms of Reference, has the existing system capacity ceased to cover the theoretical water demand at the recent time and the current water demand has already surpassed the supply.

Despite the massive investment made to overcome the unbalanced pattern of the water demand & supply by the water supply service enterprise of the town, the situation is aggravated due to the ever-increasing population growth and water demanding Institutions development followed

by declining supply from water sources and age of the entire system. The dynamics of urbanization processes accompanied with other constraints are threatening the entire water supply system & often make the daily distribution planning very difficult.

Like in many developing towns; a rapid population growth and high rural-urban migration also poses many social and environmental challenges for the town resulting in a growing commercial center in the town. However, it faces critical shortages of water and sanitation services to meet the demands of its expanding population, manufacturing industries and commercial enterprises. The situation of insufficient and unsafe water in the town resulted in communities using unprotected sources which have no access to yard or community tap and is believed to result in poor environmental conditions and an ever-present risk of epidemics, which in turn present a formidable threat to health and productivity of the citizens.

1.2 Objective of the Project

1.2.1 General objective

The general objective of the project is to assess the impact of poor selections of route of the transmission main and access roads on the overall cost of the Gundo Meskel town water supply project.

1.2.2 The specific objectives

- To assess the feasibility of the routes of transmission main the project
- To assess the feasibility of the roots of access road of the project
- To assess the transmission main pipes cost of the project
- To assess the transmission main fittings cost of the project
- To assess the transmission main appurtenances cost of the project
- To assess the transmission main trench excavation and back filling costs of the project
- To assess the transmission pipes and fitting installation costs of the project

2. PROJECT AREA DESCRIPTION

2.1 Location

Gundo Meskel town, the capital of Dera district, is the only town attaining legal personality and municipal identity in the district and found or located 110 km from North West Shewa zone capital Fiche and 220 km from regional capital Finfinne on the main asphalt road that runs from Finfinne via Fiche to Gojjam and then gravel road that detached from asphalt road to Gundo Meskel. Accessibility of the town consists of 134km asphalt road up to Sheno village followed by 86km gavel road which is in good condition. The latitude (Northing) and longitude (Easting) location coordinate of the town is 10013'44" North and 38042'01" East respectively.

Gundo Meskel town is situated in Abay River Drainage Basin. It is located in the central part of Ethiopia with an elevation ranging from 2400-2555 meters above sea level (amsl) and mean elevation of about 2475m amsl. Hills and steep slopes are found in the Northern, Eastern and Southern verge of the town following Jamma valley dissection while relatively gentle slopes span to the western.

There are three rivers draining through the town to Jamma River which is one of the tributary rivers of Abay. From these rivers Anawayou and Baro Rivers are perennial while Ambaturi is seasonal.

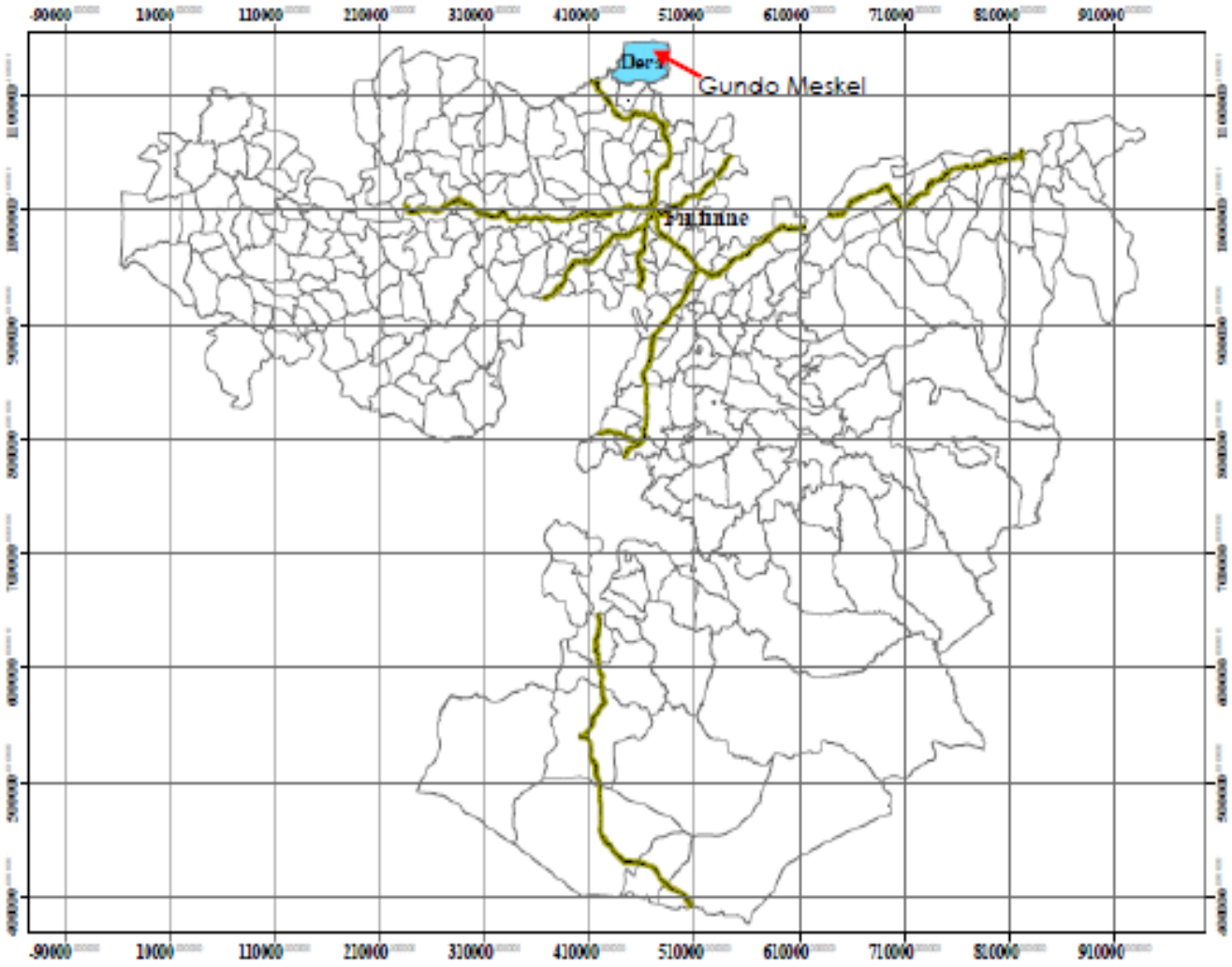

Figure 2.1: Location map of Gundo Meskel town with respect to Oromia

2.2 Physiography

Geographic diversity having high rugged mountains, flat-topped plateaus, deep gorges, incised river valleys, and rolling plains is a specific feature of the study area. The town is established on the plateau surrounded by deep cut volcanic and sedimentary escarpments. It is bounded from the west and northwest by Abay Gorge, from south and south east by Jamma River and from the north and northeast by Wenchit river gorges.

2.3 Climate

According to the Ethiopian temperature zoning, the area belongs to warm temperate climate. The study area is characterized by distinct dry months in winter season.

August is the coldest month with mean daily temperature of about 14.23 ^{0}C while April is the hottest month with mean daily temperature of the month 19.2 ^{0}C. The mean annual precipitation, potential evapotranspiration and actual evapotranspiration of the project area are 1009 mm, 1373 mm and 612 mm respectively.

2.4 Land Use and Land Cover

Land use and land cover of Gundo Meskel area consists of intensively cultivated land employed for seasonal crop like Teff, Wheat, Barley etc. accompanied with grasses, escarpments, scattered bushes and shrubs.

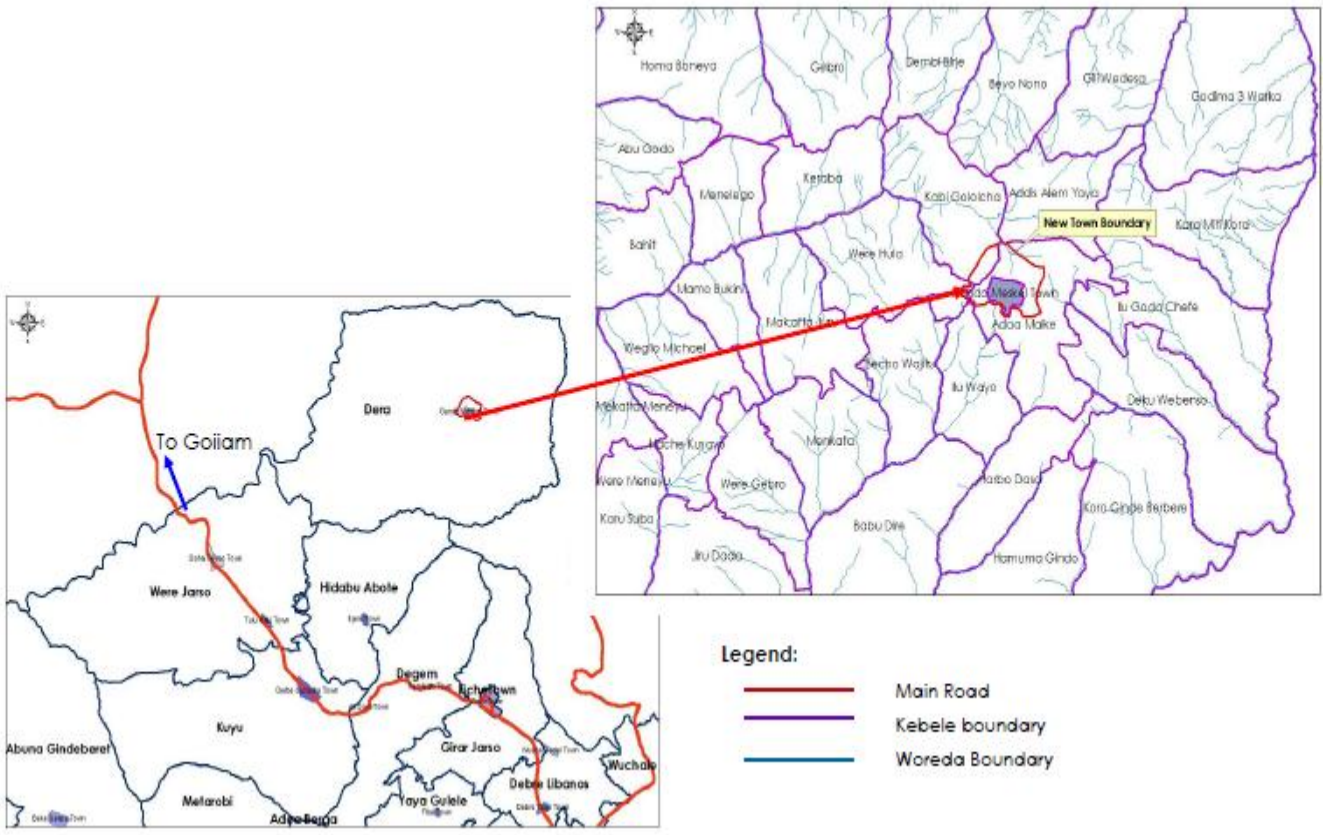

Figure 2.2: Location map of Gundo Meskel town with respect to Woreda and Kebele

2.5 Urban Infrastructure and Demography

2.5.1 Development Plan

The Regional Urban Planning Institute (RUPI) has revised the structure development plan of the town from the 1999 plan of the town in 2010 which service for the next ten years up to 2020. As per the structural development plan made, the proposed detail land use plan of the town with possible expansion for future development comprises of 1205.6 ha. of land compartment administered in to three kebeles of which the previous town coverage only accounts to 268.2 ha. which is under single administration kebele. This high area increment of the town including two rural adjacent kebeles namely Adaa Malke and Kabi Gololcha, which are currently and the town administration, imposed great delay to the works of the consultant as it is not dealt during the contract agreement and also the client have less information about the detail scope of the work requirement. The main components of the master plan revision work is preparation of spatial development framework comprised of various land use development skeletons viz. road development, Residences, Administration, Commerce and Trade, Manufacturing and Storage,

Transport, Agriculture, Forest, Recreation, Other Services and Special functioning areas of the town.

The detail of the different land use facilities could be referred from the main land use plan but here we would like to present the incremental boundary and the final proposed land use distribution pattern that are of great importance to the study and design of any development project like this water supply project.

Table 2.1 Current land use category of gundo meskel town

S/N	Land Use Category	Area In Hectare	Percentage Cumulative Area
1	Residence	230.9	19.15%
2	Commerce And Trade	138.87	11.52%
3	Service And Administration	107.65	8.93%
4	Manufacturing And Storage	90.95	7.54%
5	Road And Transport	335.76	27.85%
6	Forest	171.13	14.19%
7	Urban Agriculture	75.27	6.24%
8	Buffer Zone	15.0	1.24%
9	Recreation	40.04	3.32%
Total		**1205.57**	**100%**

2.5.2 Governance and Institutional Set-Up

Gundo Meskel town is the capital of Dera district with autonomies municipality status and is the 4B Oromia urban level town. The town is divided into 3 Kebeles that are the lowest administrative units after plan revision made in 2010. Following the plan revision, the town administration undertook a reform program aimed at bringing good governance and administration with separate state and municipal functions. The major organs of the town administration include the town council, the Mayor, the Mayor's Cabinet and sector offices and departments. The town council has established various departments and offices that are accountable for the cabinet member and the Mayor. These institutions are entrusted with planning and execution of various functions of the town administration similar to other town within the zone and region.

2.5.3 Power and Communication

Gundo Meskel town receives a 24 hours electric power supply from the national grid of Ethiopian Electric Power Corporation. The town is provided with good infrastructures that are suitable for economic activities and other development endeavors.

2.5.4 Road Network

The town is accessible from the regional and national capital, Finfinne, through asphalt road up to Sheno and then all-weather roads after Sheno to the town. In addition it has many road outlets to the surrounding rural and urban areas within the country making it comparatively with advantageous tour and commercial route.

The roadways in the town are of dry weather, all weather and asphalted types. The town is provided with good road infrastructures that are suitable for economic activities and other development endeavors. The urban road network is expected to increase substantially due to the undergoing cobblestone road construction and the due regard given to the road sector in the structural development framework. The road network proposed by the study is shown in the land use map as on figure 2-3 above.

2.5.5 Growth Potential of Study Area

The project town is developing through the establishment of large number of small to medium houses, commercial centers; urban agriculture and different scale industries resulting in high degree of population growth. In near future the town also plans to develop other important

infrastructures associated with the development of it as additional to the existing infrastructure facilities. The town has been one of the prominent towns in the country and is experiencing improved growth as a result of its situation at the center of other towns having great national importance and tourist attraction potential.

2.5.6. Socio-Economic Study

2.5.6.1 General

Gundo Meskel town is planning to undertake a project to improve the existing water supply situation of the town. The existing water supply system of the town which is supplied from one springs and two boreholes found in the town being pumped to the 50m3 and 75m3 service reservoirs located at the relatively elevated areas in the older town part has become stressed and has not been able to meet the demands of the expanding population of the town, government institutions and commercial enterprises. In addition the system is old as it has been commissioned before 15 years.

The municipality has thus called for a project study for the preparation of feasibility study and detailed engineering design of water supply system and tender documents together with the preparation of accompanying financial plans in order to supplement it.

This socio-economic study was undertaken to generate data and information on the various socio-economic aspects of the town that would provide a framework within which the design and implementation of the water supply system of the town and then the business plan study is to be undertaken.

2.5.6.2 Existing Studies and Documents

Gundo Meskel town is endowed with master plan socio-economic study documents relevant to this study. These were obtained during field visits and encounter the town and regional authorities and reviewed by the consultant. The Consultant has used this study documents and updated the secondary data from different town government offices including the municipality, finance and economic development bureau, trade and industry bureau, statistics bureau, health bureau, education bureau, the water service office and other concerned bodies to prepare this study.

The above stated study document was supplemented by data from national sources in order to better ensure the completeness of the study and to ensure its comparability with studies elsewhere. The MoWR and the CSA were useful sources in these respects.

Some of the supplementary documents that were used include:

1. CSA, Ethiopia's Rural Facilities and Services, Atlas 2009, first draft, Volume 4, Oromia regional state.
2. 1994, Population and Housing Census of Ethiopia results of Oromia Region, volume II Analytical Report.
3. MoWR, Policy and Strategy Documents

2.6 Demography

2.6.1 Population Size

To determine the current population size and growth of the population of Gundo Meskel town, two sources namely the 2010 socio-economic study of the town and information from the municipality were used. These have been used to derive the base populations for 2011 which will be used as a base to predict the future populations of the town.

The one released show a growth rate of 2.9% from 1994 to 2007 with average household size of 4.8 families per household. In addition the census result doesn't show the population figure of the town in question. So based on the base population from socio-economic survey conducted in 2010 for the town in preparation of the revised master plan of the town by the regional urban planning institute, which accounts to 16,659 residents and 2761 household size resulting in average household size of 6 persons. Using the average growth rate for the region the current population is estimated by Gundo Meskel municipality to be in the order of 17,149 in year 2011. However, using the 1994 Population and Housing Census Analytical Report Medium Variant population growth rate for Oromia Region on the other hand projects the current population of Gundo Meskel town in 2011 to be 17,408. It shows a difference of 259 from the one obtained using the 1994-2007 average growth rate projection. The difference in the size of the population of Gundo Meskel estimated on the basis of the two censuses is due to differences in assumed growth rates. The population size for the two census comparison is as tabulated below.

Table 2.2: Estimated Current Population of Gundo Meskel town based on the 1994 &2007 census population growth trends

2007 Census			**1994 Census**		
Year	**Population**	**GR%**	**Year**	**Population**	**GR%**
2010	16,659		2010	16,659	
2011	**17,149**	**2.9**	**2011**	**17,408**	**4.40**
	Avg HH size	6.0			6.0
	No.of HHs	2,842			2,885
Sex	Male	8,592	50.10%		8,722
	Female	8,557	49.90%		8,687
Age ,years	<15	5,711	33.30%		5,797
	15-64	10,958	63.90%		11,124
	>64	480	2.80%		487
Ethnic	Oromo		75.1%		
	Amhara		24.9%		
	Orthodox		67.1%		
	Muslim		32.3%		
	Protestant		0.6%		

2.6.2 Population Size and Structure

A summary of the population structure, according to the latest socio-economic survey, is shown on Table above. The table summarizes the current population, age, sex, religious and ethnic compositions. It also shows the number of households and average household size.

As can be seen from the table, a total population of 17,408 was projected for Gundo Meskel in 2011. The total population of town is made up of 2,885 households.

2.6.3 Population Projection and Growth Trend

Population projections for Gundo Meskel town for the coming fifteen years have been undertaken on the basis of the base populations of 2011 obtained and medium scenario growth rates set by 1994 CSA analytical report for Oromia region. The 2007 census growth rate of 2.9% used for the region as average value is considered very low and shall not been applied for population prediction of the town.

The exponential growth formula recommended by CSA and used for the projection is:

$$P_n=P_o(1+r)^{\wedge n}$$

where:

Pn=population at n years

Po= base population

r=population growth rate (%)

n=projection year

2.6.4 Socio-Economic Structure

2.6.4.1 Sources of Employment and Income

Gundo Meskel town is growing from time to time as commercial, tourist attraction and agricultural centre of Dera district although it is not much endowed with these socio-economic structures so far. According to the revised master plan of the town; the urban area of the town is about 1205.6 hectares. The urban area increased after repeated revision of the master plan reflecting the growth of the town from 268.2ha before 2010. Based on this trend, it was projected that the urban area will expand further in the coming years. Current plans are for higher expansion. Under the current master plan, various development activities are under way to ensure this. The plan calls for all round expansion that includes residence, urban infrastructure, administrative and commercial activities and urban agriculture.

2.6.4.2. Public Institutions

With the devolution of power to town administrations, following the second wave of decentralization, Gundo Meskel town has established an independent administrative

Status with its own civil service structure and financial management. It collects local taxes and employees required staff. Reflecting its growth as an administrative centre, public institutions are one of the major sources of employment and income for the town.

2.6.4.3 Commercial Enterprises

The growing commercial identity of the town can be seen from the expanding number of registered and active enterprises in the town. Data provided by the Trade, Industry and Transport Office shows that there are 961 officially registered and active commercial enterprises. Out of these 742 are retailers, 202 services, 5 wholesalers and 13 are manufacturing. The formally established business enterprises within the service type are shown in the following table:

Table 2.3: Number of Business Enterprises in Gundo Meskel

No	**Trade activities**	**Number of Trade Activities**								**Total**
		Whole sale		**Retail**		**Service**		**Manufacturing**		
		No	%	No	%	No	%	No	%	
1	Hotel					7	3.5			7
2	Tea room					16	7.9			16
3	Different shops			733	98.9					733
4	Butchery					13	6.4			13
5	Private clinic					7	3.5			7
6	Pharmacy					2	1.0			2
7	Juice house					1	0.5			1

No	Trade activities	Number of Trade Activities								Total
		Whole sale		Retail		Service		Manufacturing		
		No	%	No	%	No	%	No	%	
8	Tej bet					5	2.5			5
9	Grocery	2	40.0			6	3.0			8
10	Tailor					124	61.4			124
11	Chat			2	0.3					2
12	Grain shop			3	0.4					3
13	Grain mill							11	84.6	11
14	Barber					13	6.4			13
15	Edible oil							1	7.7	1
16	Electric shop			3	0.4					3
17	Fuel station							1	7.7	1
18	Salt	3	60.0							3
19	Restaurant					8	4.0			8
Total		5	100.0	741	100.0	202	100.0	13	100.0	961

Source: RUPI, report on structural plan of Gundo Meskel and town administration, January, 2003 E.C.

In addition to the formally established business enterprise there are about 63 non-formal enterprises particularly engaged on services and retailer.

Although the numbers could not be established with certainty, it is believed a significant number of employments have been generated by these enterprises.

2.6.4.4 Social Infrastructure and Services

2.6.4.4.1 Health

The town of Gundo Meskel is provided with one health center, four private clinics and 2 drugstores. There are also 4 recognized traditional medicine outlets. The summaries of healthy institutions found in the town are as shown below.

Table 2.4: Health institutions in Gundo Meskel

Type	Number	Ownership
Health Centre	1	Government
Clinic	5	Private
Drugstore	2	Private
Health Post	8	Government

Institutions are served by professional health staff as shown in the following table 2.5

Table 2.5: professional health staff in health institutions

s/n	Professional	Number in:			total
		Health centre	clinics	pharmacy	
1	Health officer	1			1
2	Health assistants	1			1
3	Senior nurses	2	5		7
4	Health extension workers	4			2
5	Pharmacists			2	4

A review of the ten most prevalent diseases in the town as received from Gundo Meskel Health Center shows that water borne diseases are common. The number of cases of different diseases and their shares in totals for 2009/10 is shown on table below.

Table 2.6:Ten Top Causes of Mortality in Gundo Meskel Town

No.	Diseases	Health Office	
		No. of Patients	%
1	Rheumatism	1328	24.66%
2	Skin Infections	1175	21.82%
3	Gastrites	720	13.37%
4	UPT	697	12.94%
5	Pnemonia	510	9.47%
6	Epilepsy	261	4.85%
7	Iron Deficiency	245	4.55%
8	Helemetiy	165	3.06
9	Aneamia	150	2.78%
10	Romatic Artarti	135	2.5%
	TOTAL	5386	100.0%

2.6.4.4.2 Education

The town have four educational services/schools/, One-KG, One-lower primary school serving KG and grade 1-4, One upper primary school serving grade 5-8 and One high school serving grade 9-12 . The details of student and teacher enrolment and student-teacher ratios per the schools are as stipulated below.

Table 2.7: Educational Institutions in Gundo Meskel

Names Of Schools	**Grade Level**	**Number of**		**Student Teacher Ratio**
		Student Registered	**Teacher**	
New Generation Academy(Private Owned)	**KG**	**108**	**3**	**36:1**
	1-4	33	2	17:1
	total	141	5	28:1
Dera No.2 School	**KG**	160	2	80:1
	1-4	1932	25	77:1
	total	2092	27	77:1
Dera Yenege Bruh Tesfa School	5-8	1444	26	56:1
Bitotessa 17secondary and Preparatory School	9-12	2442	55	44:1

2.7 Water Supply Situation

2.7.1 General

An earlier study(1992 E.C,by NGO menschen for mention) showed that safe drinking water is not available to all households of the town from municipal sources. However; there are springs and perennial rivers in the town surroundings to provide the town residents as alternative sources. Only 21.3% of the households are said to have direct water lines to their houses for which drinking water is not available on a regular basis in a reliable manner and in sufficient quantity. In addition about 21.8% of the households are supplied with public fountains located at different town parts. The remaining 56.9% of the town residents are forced to use traditional sources from unprotected springs and perennial rivers that flow through the town.

The situation remains unchanged; the existing water supply system which is supplied from two boreholes and one spring, namely Baro-2 and Chelelek boreholes and Baro spring, found in the town are pumped to the 50 m^3 and 75 m^3 service reservoirs, respectively, located at the relative elevated areas to feed the older town part. The system capacity has become stressed and not been able to meet the demands of the expanding population of the town, government institutions and commercial enterprises.

2.7.2 Management

The town water supply is managed by its own water service office accountable to the municipality office. But recently the town municipality is interested to establish its own water supply board of directors which should be chaired by the chief of the municipality and different members represented from finance and economy, health office, water service office and women's affairs which shall be nominated in line with the regional proclamations.

The utility have a separate technical, administration and finance and audit sections accountable to the head of the utility. The towns day to day smooth water supply system provision; the utility has currently 10 permanent and 7 contract staffs. In addition it also hires 6 water sellers on daily basis for operating the public fountains. In general the ratio of staffs with the customers based on the current population is 1024, which might be much lower if it is compared with the actual beneficiaries. This is one of the areas that need to be looked to enhance the productivity per staffs.

2.7.3 Water Production

The current sources of the water supply system of the town are two boreholes developed at different times and locations plus one spring. As per the information collected from water service office, the yield from the two boreholes, namely Baro-2 and Cheleleki, are estimated at 2l/s and 1.0l/s, respectively while the spring yield is estimated at about 0.67l/s. However, due to own technical problem at the time of site visit, Cheleleki borehole is not functional. From these sources a town water service office will distribute about 150 m^3 (110 m^3 from Baro-2 borehole and 40-50 m^3 from Baro spring) of water a day. In addition to the existing sources from the boreholes and spring, there are also four shallow wells with unknown yields equipped with hand pumps in the town periphery aimed to serve the residents which are constructed by the district administration in 2010.

2.7.4 Water Tariff

The water tariff for Gundo Meskel didn't change for a long time. The tariff that is in use is during reconnaissance survey is 6.0 birr/m^3 for private connection users. However, the water service office changed the tariff rate to 10.0 birr/m^3 for connection since then.

The tariff rates don't differentiate between consumer categories. Flat rates apply to all types of consumers and also rates do not increase with the amount of water used by customers

2.7.5 Water Sales

Water is sold through direct connections at house and yard connection, which might be private and shared, and public fountain. There are currently 11 public fountains of which one is not connected to the system, 8 commercial, 9 government and 7 NGO institutional connections and 366 private connections during reconnaissance study. However; since then, although there is huge water shortage in the municipality, the water service office has made additional 252 private connections up to last month which boosts the number of private connections to 618. Detailed breakdown of customers by type of connection was not available but according to the office private customers in yard connection mode are the major customers to house connection users.

2.7.6 Revenue and Expenditure

The Gundo Meskel Water Service Office did not have a double entry accounting system until the year i.e. 2004. At the time of the site visit no account statement has been prepared that showed a complete financial analysis of its operations. However, the water supply office owns a balance of 30,000 birr in his account.

On the other side, it possible to conclude that the water service has been operating on surplus in the last years which is obtained after financing its operation and maintenance costs. However; at this stage re-financing of the capital costs and setting aside of depreciation allowances could be a challenge.

Expanded with a view to meet demand over the next 15 years to flourish the plan of the town administration and hence town development.

2.8. Existing Water Supply System

2.8.1 Assessment of the Existing Water Supply Situation

The status of the present water supply system is assessed technically and socio-economically. The results of the analysis form a base for the feasibility study and detail engineering design of the envisaged water supply system facilities.

The consultant has undertaken the detail study and gets a clear understanding of the existing water supply facilities and operation and maintenance of the scheme. The consultant has also identified core problems to formulate the possible short and long term strategies to mitigate currently observed problems. The existing water supply conditions of the town are briefly described as follows:

- Problem of access to water points**:** The inhabitants living in the town are facing a serious water shortage problem. Especially people residing very close to service reservoirs, expansion areas of the town and town part located at relatively higher altitudes compared to the existing service reservoir sites are fetching water from vendors at an exorbitant cost than the normal water tariff set by the utility or from traditional sources which cause health hazards to the town beneficiaries.
- Time wastage**:** the dwellers routinely spend a significant proportion of their time queuing up at improved public fountains and some at unprotected sources;
- Supply interruption**:**

(i) Due to lack of sufficient water source; the town dwellers will not get water regularly.

(ii) The supply system is frequently interrupted by lack of standby generators during power failure that nationally occurs frequently, particularly at Baro-2 borehole which is the prominent water source at the current time.

(iii) System failures also occur frequently and timely repairs are not made, reportedly, due to unavailability of appropriate maintenance equipment's within the town water supply utility;

- Inadequacy of water source: Unavailability of high yielding productive springs/boreholes, decrement of borehole and fluctuation in spring yields from time to time and season to season;

- Unlinked sources and distribution systems**:** stretch of spring sources and isolated pipe segments each with its own problem is commonly observed in the town water supply system. Had the water sources are collected at one place; probably the 50m3 reservoir around Georges church due to its higher elevation compared to major part of the existing town, the distribution efficiency have be raised from the current situation;
- Aging of water supply facilities**:** drop in efficiency of the system facilities due to aging which resulted in higher leakage.

With the current water supply situation; the percentage of population being benefited from the existing system is below 43.1%. The remaining population of the town which accounts to about 56.7% is categorized as part of town population using traditional sources and/or those using water from their neighborhood venders.

2.8.2 The sources of water

In the existing water system; raw water from the spring and two boreholes is pumped to two different service reservoirs located within the town skirt. The first reservoir which is constructed in 1986 E.C with capacity of 75 m^3 collects water from Baro spring while the second with capacity of 50 m^3 constructed in 1992 E.C collects water from Chelelek and Baro-2 boreholes

In general the existing water supply source of Gundo Meskel town is not at all compatible to the water demand of the town. The present total daily water output from the two boreholes and spring are about 150 m^3 which is very far behind the required water demand of the town. The situation is even aggravated after failure of the Cheleleki borehole source with average daily production of 16 m^3. Although fully detailed springs history reports are not availed to the consultant, the town water supply utility employees have rendered some information regarding the spring nature, yield capacity and other relevant well data to the consultant verbally. In addition due to the full capping of the spring; the consultant haven't conducted exact measurement of the spring yield through any convenient methods at point of tapping. However, at point of collection, particularly at the pumping station; the yield of the springs is estimated at about 0.67l/s, respectively. The yield of the two boreholes at the current time as per the information gathered from the water supply service office is 2.0l/s and 1.0l/s for Baro-2 and Chelelek, respectively.

The total present water production capacity of the town is estimated at about 2.67l/s (as a result of fail of Chelelek borehole) which are by far below the water requirement of the town to make full water supply coverage.

Hence; looking for alternative source development overcoming the existing source problems and hindering the source water supply problem is the no choice option to be conducted.

2.8.3 Existing Water Storage and Transmission Facilities

The water from Baro spring is first collected in collection chamber constructed at a distance of approximately 50m downstream of the spring eye and then pumped to the 75m3 capacity reservoir near Tele(local name) through the existing diameter of 2 inches 1.2 km galvanized iron transmission main pipes. These mains are exposed over ground areas resulting in higher exposure to damage.

The water from Baro-2 and Chelelek boreholes are collected to the 50 m^3 service reservoir located near mention compound and Georges church at a distance of about 3.2 Km and 3.7 Km, respectively.

- Mention compound reservoir

The ground level masonry sandwich having 50 m^3 capacity is constructed in 1992 E.C during rehabilitation of the town water supply system by NGO, Mention. The reservoir is equipped with 2 ½ inches inlet from Baro-2 and Cheleleki boreholes and 2 ½ inches outlet to serve the surrounding town residents by gravity.

- Tele reservoir

This reservoir is made of sandwich masonry with capacity of 75 m^3 constructed in 1986 E.C during the first set up of modern water supply system to the town having one 2 ½ inches inlet from Baro spring pumping station and one 2 ½ inches outlet. The reservoir is constructed by the government.

- Baro Spring Collection Chamber

This collection chamber having capacity of 20 m^3 and constructed in 1986 E.C. is fed from Baro spring by gravity and conveys water to the Tele reservoir by submersible pump installed in it through 2 ½ inches transmission main. The transmission main serves the communities along the

line before it conveys water to the service reservoir at Tele. This method of water supply system causing drop in efficiency of the pumps during operation and little or almost null amount of water will be invaded to the reservoir for demand balancing

2.8.4 Water distribution and Conveyance facilities

The water transmission, storage and distribution of the existing functioning water supply system consist of one boreholes and spring with total yield of 2.67 liter/second, 2 ½ inches rising/transmission main 20, 50 and 75 m^3 collector and service reservoirs, distribution network, 642 private connections and 11public fountains of which 10 are connected to the system and hence giving service at the current time. The service reservoirs are not in good condition at the current time and hence regular maintenance. The capacity of the existing reservoir is even not sufficient enough to balance the actual water demand and the pumping supply.

The existing distribution pipes in the system are made up of GI pipes with size ranging from 1 to 2 ½ inches. The actual lengths of the pipes in the network are not known due to lack of documentations.

It is observed by the team of experts during the site visit that some remote areas, areas with relatively higher elevations and inaccessible localities of the town are not covered by the present distribution network.

2.8.5 Existing Water Users

The water services provided by Gundo Meskel town water supply utility includes domestic, commercial, institutional and public consumptions. At the current time the town water supply utility although owes such big water supply problems have 618 private customers, 9 government institution, 7 NGO institutions and 8 commercial customers which added up to 642 total customers.

The remaining population of the town will get water either through purchase from vender or use of the 10 functional public fountains and from traditional sources. Purchase from venders or use of public fountains are not only bounded to the population without private connection but also with those having private connection when water from their compound gets off as the town faces sever water supply problem.

2.8.6 Shortcomings of the Existing Water Supply System

The shortcomings of Gundo Meskel water supply system as observed during the field visit, as of the information collected from the water utility and the information gathered from other relevant sector offices; have been observed and dealt as follows:

- The existing distribution network is not properly planned to supply water at the taps of residents with adequate pressure. Some parts of the town are not yet covered by the existing distribution network or even those covered haven't get water yet due to lack of sufficient source added to the system and residual pressure to lift water to the areas of need.
- The capacity of the available sources is very small even for the current demand. So need of further source development is the no option based solution for the town.
- As the system performance hinders the supply of potable water to many residents of the town, unimproved source users increase progressively than those who can afford to consistently pay for water from improved system.
- The major observed defects on the existing water system are; under sizing and improper laying of pipes, direct pumping to the beneficiaries resulting in longer pumping hours with under efficiencies, the absence of control valves, the absence of thrust blocks, and other appurtenances, etc. are evidently showing that the implemented system has not taken seriously these vital components implying that previous water supply projects had not been considered as sustainable long-term "Projects but as "Emergency Water Supply projects" which respond to immediate needs".

2.9 Population and Population Projection

Planning of water supply and sanitation system involves understanding of the current as well as future requirements of communities and applying engineering principles to design adequate water supply and sanitation infrastructures. Such planning will consider the availability and quality of source, sitting considerations, environmental and social impact, projected population figure, socio -economic condition (income, customer's willingness and ability to pay), future operation and maintenance cost, institutional aspect and environmental factors.

There are number of factors that should be taken into consideration to forecast population of a particular town; such as fertility, mortality, economic activity in and around the project town,

availability of potential natural resources, status of the town in the region i.e. its political and economic significance, relative location of the town with respect to main high ways, availability of reliable and ample urban infrastructure and etc.

Thus, the consultant will consider population projection over the design horizon and the remaining demand projection and environmental and social Impacts will be discussed in the next chapters.

In projecting the population of a particular town, it is very important to analyze the overall town's resources and capacity so as to avoid the risks of either under designed system resulting in a reduced system capacity or over designed system resulting in incurring a heavier investment cost influencing the socio-economic conditions of the residents of the town. Hence; to avoid such risks the consultant has reviewed all the available premeditated documents, data and information obtained from different governmental institutions and previous studies.

Gundo Meskel is expanding due to many factors that include its position as a trading and business center, tourist attraction due to natural and manmade estuaries in line with adequate transportation and communication facilities, location among two different regions, endowment with different investment opportunities accompanied with expansion of educational and health facilities, industries, and government offices.

In due of such facts, the main milestone for a realistic and viable water supply project design is to have a well-conceived assessment of population and economic growth supported by current/future land use plans, and as far as possible, an accurate projection of water consumption and demand pattern.

Reliable estimate of present and future demands can only be determined based on available and agreed population and economic projections. To have such estimate, the legally authorized Central Statistical Authority data source for base population and determination of growth rate is preferred. However, due to lack of CSA statistical data particular to the town; use of the 2010 detail socio-economic study by the RUPI and the 1994 CSA Analytical Report on population growth rates for **Oromia Region Urban Areas** are adopted for the projection of future population. According to the 2010 socio-economic study of the town reported the population of the town is **16,659**.

2.9.1 Population Projection

Population projection for Gundo Meskel town is made using projection of the 2010 base population to 2011 and then to the design horizons using the 1994 adopted growth rate as stipulated on **Volume II Analytical Report for Oromia Region**. On this analytical report, CSA has made population projection for both rural and urban settlements up to the year 2030 in three variants; namely high, medium and low for the regional state in question.

In line with this growth trends, the consultant also observed different growth rate pattern of the town and compared it with that set by CSA in 1994. In line with this, population projections for this particular study is made based on different growth rates adapted and different projection methods and analytical reports. Among the CSA growth rates, the low, medium and high variant urban growth rates adapted for Oromia region in the 1994 CSA Analytical Report up to year 2030 is used while the rest such as the average growth rate from 1994 to 2007 for Oromia region and MoWR January 2006 design criteria for urban water supply projects are used as comparison of population projections.

There is always a greater intricacy in deriving population projections for geographic areas like Gundo Meskel town, which is experiencing rapid growth and expansion. Besides, projection becomes less reliable when it is made for a small portion of the area than for the whole geographic area. This is mainly because of the fact that projections made for larger geographic areas use large population base that will be less likely to exhibit short-term variation. Likewise, projections made for longer target year of the project become statistically more reliable than that made for shorter duration as inputs to the projection are based on calculations rather than actual figures.

To make the population projection of the town more reliable and to reach at dependable figures, the consultant has been working by considering the current and future development patterns of the project area.

In line with the town development trend, the exponential growth rate model has been used in projection of the population in same way as similar towns in the country exhibiting such development trends.

Table 2.8: Population growth rates set by CSA and MoWR

Census conducted	Year				
	2006 2010	2011 2015	2016 2020	2021 2025	2026 2030
Low	4.30%	4.10%	4.00%	3.80%	3.50%
Medium	4.60%	4.40%	4.20%	4.00%	3.80%
High	5.00%	4.80%	4.70%	4.50%	4.40%
2007CSA avg.growth rate for oromia	2.80%				
MoWR,2006	4.06%	3.88%	3.69%	3.51%	3.35%

2.9.2 Population projection

The consultant has presumed medium variant population growth rate set by 1994 CSA for planning purpose and the 2010 RUPI population census data as a base to be the most reliable source because of the following reasons:

1. The 1994 projection has amended the growth rate of CSA to a reasonable and agreed value taking into account different factors that affect the dynamics of Population like education, household size, number of births per active woman, life expectancy, migration and others.
2. The 2010 RUPI population census figure is taken as a base population for future planning of the town's water supply system due to the fact that some peripheral areas currently added to the town are not considered and in the same way the 2007 CSA statistical report doesn't solely address the town of Gundo Meskel.
3. Even though it was agreed among different parties that the CSA figures are reliable from data gathering and projection method points of view, it is carefully considered that some reservations related to floating population (temporary or fluctuant residents), death due to AIDS which is very significant and migratory population from different parties of the country to the town will enable in estimating a more accurate figure of population to be benefited from the implementation of the project. This assessment makes the projection more realistic as the reservations either decrease or increase the number of population:

the first and second reservations have decreasing effect while the third is contemplated as special study related to the dynamics of the town.

4. The 2.9% growth rate adopted for Oromia regional state from the years 1994 to 2007 overlooks the growth trend of towns as town grow faster than rural areas and also doesn't take into consideration the dynamic changes of different towns due to their capacity to attract different investors, their topographic nature for future expansions, etc. This indicates that the assumed growth rates have not taken into account the overall population growth pattern of the town which is probable to saturate sometime in the future.

2.10. Water Demand Estimation

2.10.1 General

Projected population figures, per-capita demand and percentage share of different mode of services are important parameters for water demand estimation of the project for the anticipated design periods. The per-capita demand and percentage share of mode of services can be estimated based on the past and current consumption pattern of the community.

Usually demand estimation is made based on statistical analysis of water consumption pattern and the development trend of the study area. But the exactness of the per-capita consumption and demand for other uses (commercial, institutional, public, livestock, gardening, etc.) depends on the availability of reliable and comprehensive database. There are different methods employed for demand estimation some of which are time extrapolation, per-capita demand approach and coefficient methods. However, due to limited researches and hence no sufficient data base available, these methods are only rarely used in Ethiopia and other developing countries.

Thus, to estimate the water demand as accurately as possible; it is important to compare the existing water consumption records over the past several years with estimated water requirement as per the standard recommended figures. This correlation assumes that all the inhabitants of the town use piped water supply with an affordable price through different mode of services.

2.10.2 Classification of Demand

The consumed water based on the type of users and purpose of water consumption can be classified as domestic water demand, non-domestic water demand and non-revenue water.

2.10.3 Domestic Water Demand

Domestic water demand is a water demand at a household level needed for drinking, food preparation, washing, cleaning, bathing and other miscellaneous domestic purposes. The amount of water used for domestic purposes greatly depends on the lifestyle, living standard, and climate, mode of service and affordability of the users.

2.10.4 Mode of Services

According to the data obtained from the Gundo Meskel Town Water Supply Service Enterprise; there are three types of Mode of services practiced before in the town which are mentioned as follows.

- House connections (HC)
- Yard connections (YC)
- Public fountains (PF)

The current mode of services classified as per the data obtained from the water supply service enterprise based on the percentage of current total water coverage are as tabulated below.

Table 2.9: Percentage mode of services based on current coverage

Mode of Service	**Percentage of Population Served**
HC	1.3%
YC	11.9%
PF	18.0%

2.10.5 Mode of Service Projection

The mode of services projection is made based on the target design year 2028 of the project at which the town water coverage will become 100% and the communities will get sufficient amount of water they require considering the current mode of services as a reference. In the future as a result of development of the town associated with willingness of residents to have their own connection and pay more for the water they use; it is forecasted that at the target year of 2028, the percentage of users in HC mode of services 10% while yard connections 60% and public fountain users 30% from the current mode of service.

Table 2.10: Projected Mode of Services in %

Mode of service	2011	2013	2018	2023	2028
HC (%)	1.3	2.2	6.7	9.0	10.0
YC (%)	11.9	33.6	49.0	56.7	60.0
PF (%)	18.0	64.2	44.3	34.3	30.0

2.10.6 Per-Capita Demand

According to the design criteria for urban water supply projects prepared by Ministry of Water Resources published in January 2006 and considering the effects of the factors that make the demands to be biased , the estimated current domestic water demands for each mode of services and the daily activities for water consumption have been determined as follow.

Table 2.11: Domestic Water Demand (lpcd) in 2011-2012

Activity	**HC**	**YC**	**PF**
Drinking	4.0	4.0	4.0
Cooking	10.0	8.0	3.5
Ablution	6.0	5.0	3.0
Washing Dishes	6.5	4.0	2.5
Washing Clothes	10	9.0	2
Toilet	3.5		
Others			
TOTAL	**40**	**30**	**15**

The usual trend in water demand assessment is that as the people get more and more education and when economically become well, their life style will change and their standard of living will also improve which necessitates increased water demand.

The following table illustrates the projected per-capita consumption set for different mode of services.

Table 2.12: Projected per-capita water demand (lpcd) by Mode of Service

Mode of service	**2011**	**2013**	**2018**	**2023**	**2028**
HC	40	50	75	85	90
YC	30	36	50	57	60
PF	15	18	25	28	30

Based on the above mode of service and presumed per-capita water consumption; the average day water consumption of Gundo Meskel town at the end of the design period is found to be 54.0 liter per-capita per day(note that we do have 55.0 l/c/d water sources from two springs as shown on table 2.22). This per-capita water demand is found reasonable when compared to the current water supply coverage and the 8.6 liter per-capital per day consumption exclusive of water loss in the system.

However; this values will be change based on the socio-economic and climatic adjustment factor of the town.

Based on the nature of the town revealing that the town would have high potential for future development although enjoying low living standard at the current time and also having precipitation in the range of >900mm per annum; the average socio-economic and climatic adjustment factor of 1.05 and 1.0, respectively will be used as sited on the design criteria set by MoWR January, 2006 for urban water supply projects.

So in aggregate the consultant will use socio-economic and climatic adjustment factor of 1.05 for the town domestic water demand adjustment.

For comparison of results the consult have also compared domestic water demands of some towns in the country with almost similar growth rates and nature to estimate the most appropriate values for Gundo Meskel. The domestic water demand considered in the comparison is dictated on one side by the population differentiated needs, by whole economical and financial affordability, and their willingness to pay for the service rendered. The figure compared shows that the consumption pattern of towns and cities of similar standard and consumption pattern are more or less similar and are within the recommendations by Ministry of Energy and Water.

Table 2.13: Comparison of domestic water demand and mode of service for different towns in the country

Town/location	**PF**	**YC**	**HC**
Amhara region(8towns)	30	70	110
Tigray region(8 towns)	30	70	110
Oromia six centers water supply project	25	55	100
25 towns water supply projects	30	60	90
		PF=public fountain	
		YC=yard connection	
		HC=house connection	

In estimating the domestic water demand, it is assumed that the existing neighborhood tap users are assumed to have per-capita water equivalent to public tap users.

After the percentage share of different mode of services and the corresponding per-capita demands is determined, the total domestic demand have been calculated for the town residents as indicated in Table 2.10. As indicated in the table, the average domestic water demand at the end of the project design phase is in the order of 1,987m^3/day.

The following table illustrates the average domestic water demand of Gundo Meskel town for the coming years.

Table 2.14: Summary of domestic water demands

Description	**unit**	**Year**				
		2011	**2013**	**2018**	**2023**	**2028**
Population growth rate		4.4%	4.4%	4.2%	4.0%	3.8%
Total population	No.	17,408	19,009	23,545	28,873	35,053
Coverage by service type						
HC	%	1.3%	2.2%	7%	9%	10%
YC	%	11.9%	33.6%	49%	57%	60%
PF	%	18.0%	64.2%	44%	34%	30%
Person per connection		6	6	6	6	6
Person per PF		300	300	300	300	300
No connections						
HC		37	37	261	431	581
YC		329	329	1912	2713	3486
PF		10	10	35	33	35
Total number of connections		376	376	2208	3177	4102
Population to be served by						
HC		233	418	1,578	2,599	3,505
YC		2,074	6,387	11,537	16,371	21,032
PF		3,135	12,204	10,430	9,903	10,516
Total population to be served by		5,442	19,009	23,545	28,873	35,053
Domestic per capital demand						
HC	l/c/d	40	50	75	85	90
YC	l/c/d	30	36	50	57	60
PF	l/c/d	15	18	25	28	30
Socio-economic and climatic adjustment factor		1.05	1.05	1.05	1.05	1.05
Consumption						
HC	M^3/d	10	22	124	232	331
YC	M^3/d	65	241	606	980	1,325
PF	M^3/d	49	231	274	291	331

Description	unit	Year				
		2011	2013	2018	2023	2028
Total consumption	M^3/d	124	494	1,004	1,503	1,987

2.10.7 Non-Domestic Water Demand

Water demands of institutions, public areas and commercial centers will be determined based on the type and nature of services available. However; as most towns in the country are immensely growing; no such distinct categories will be identified. So it is solely important to consider this demands as some factors of the domestic demand due to the fact that the growth of such demands is in parallel with the development of the town and hence the need for domestic consumptions.

Generally, in Ethiopia such water demands are estimated as a percentage of the domestic demand. It is considered usually to be in the range of 5% to 10% of the domestic demand for public water demands, 10% to 15% of domestic water demand based on the degree of development of the town(*Design_criterea_FDRE_Minstry of Water Resources_07 June 2007_Zelalem).*

For this study, 5% of the domestic demand is considered for public purposes and 10% for institutional and commercial demands for normally growing residents and residents in condominium areas.

2.10.8 Peripheral Water Demand

The demand imposed on the water supply system due to the population from the surrounding areas in search of work establishing temporary or permanent illegal

Settlements at the town periphery will be accounted. Thus, an additional demand which is assumed to be in the order of 3% of the domestic demand has been applied for this demand.

Taking the percentage for institutional, public and commercial as well as peripheral water demands; the non-domestic water demand category is found to be in the order of 18% of the daily domestic demand equivalent to 357.7 m^3/day at the end of design period.

Table 2.15: Summary of peripheral, public, institutional and commercial water demand

Description	Unit	Year				
		2011	2013	2018	2023	2028
Peripheral,public,institutional and commercial						
No.ofconnections	No	24	24	25	27	28
Total consumption	M^3	22.4	88.9	180.7	270.5	357.7
Consumptions	l/con/d	934	3,669	7,092	10,103	12712

2.10.9 Industrial Water Demand

Heavy industries will impose large stress on the town water supply projects. In due of this, it is recommendable to have their own sources if they are going to be implemented in the town. However; small-scale industries such as flourmills, oil extracting plants, bakeries, etc. are categorized as institutional and commercial for which the municipality will give service.

With regard to this study, the industrial water requirement is taken to be 5% of domestic demand to be considered as there is no distinct indication of type and size of industrial development although the master plan reveals that there is land reserved for future industrial development. The consultant also believes that if further future industrial development can cause water stress on the municipality; it is recommended that the industries can have their own water supply systems.

Table 2.16: Summary of industrial water demands

Description	Unit	Year				
		2011	2013	2018	2023	2028
Total consumption	M^3/d	6.2	24.7	50.2	75.1	99.4

2.10.10 Non-revenue Water

Water losses in the water supply distribution system, illegal connections, overflow from reservoirs, improper metering, etc. are referred to as non-revenue water. There are no properly set water production and consumption records to estimate the probable water loss in the water supply system of Gundo Meskel town. It is very crucial to estimate this quantity as it usually

varies from 15% to 50% depending on the age of pipelines in the system, operation and management capacity of the utility operator and the size and complexity of the distribution system.

However, the consultant has proposed that the utility would work on identification and prevention of leak, accordingly leak detection would be a core process for the utility to save water for the domestic use. The study proposes the decreasing rate of unaccounted for water and considered the values set here under.

These values are proposed in light of the assumptions that Gundo Meskel Water Supply Service Enterprise will be established with mandated work to minimize the illegal connections, carry on timely maintenance where failure occurs, monitoring of the water supply system for leakages in the future and replacement of aged facilities as required. It is also pointed out that better supervision will be provided for the newly implemented system. Calibrating the water meters and planned replacements at appropriate and planned time should be given due consideration by the enterprise in order to minimize losses in the future.

The following table illustrates the unaccounted for water loss based on the above suggestion for the coming years.

Table 2.17: Summary of unaccounted for water

Description	**Unit**	**Year**				
		2011	**2013**	**2018**	**2023**	**2028**
Un-Accounted For Water	%	25%	25%	23.0%	22.0%	20.0%
Un-Accounted For Water	M^3/d	38	152	284	407	489

2.10.11. Average Water Demand

The average water demand can be determined by adding the three categories of water demands: namely domestic, non-domestic and industrial water demands. Unaccounted for water will also be added to this sum. The average water demand represents the daily demand of the town averaged over the implementation period.

Table 2.18: Summary of average day water demands

Description	**Unit**	**Year**				
		2011	**2013**	**2018**	**2023**	**2028**
Total Population To Be Served	No	5,442	19,009	23,545	28,873	35,053
Total Domestic Consumption	M^3/d	124	494	1,004	1,503	1,987
Totalperipheral,Public,Institutional And Commercial Consumption	M^3/d	22.4	88.9	180.7	270.5	357.7
Total Industrial Consumption	M^3/d	6.2	24.7	50.2	75.1	99.4
TOTAL WATER DEMAND	**M^3/d**	**153.1**	**607.7**	**1,234.6**	**1,848.6**	**2,444.6**
Un-Accounted For Water	M^3/d	38	152	284	407	489
Avg Day Demand	M^3/d	191	760	1,519	2,255	2,934
Avg Day Demand	l/s	2.2	8.8	17.6	26.1	34

2.10.12 Maximum Day Demand

The daily water consumption varies from one day to another. Maximum water demand represents the water consumption in a day which is higher than the normal or average day water consumption. Daily water demand changes with seasons of a year and days of the week. The ratio of the maximum daily consumption to the mean daily consumption is called the maximum day factor. Maximum day factor usually varies between 1.1 and 1.3(*Design_criterea_FDRE_Minstry of Water Resources_07 June 2007_Zelalem)*. For this particular town the consultant has adapted the maximum day factor of 1.2.

Using the stated maximum day factor and the average daily demands stated above at different years within the design horizon, the maximum daily demand of the town in question is computed as follows.

Table 2.19: Summary of maximum water demands

Description	**Unit**	**Year**				
		2011	**2013**	**2018**	**2023**	**2028**
Avg Day Demand	M^3/d	191	760	1,519	2.255	2,934
	l/s	2.2	8.8	17.6	26.1	34.0
Maximum Day Factor		1.2	1.2	1.2	1.2	1.20
Maximum Day Demand	M^3/d	230	911	1,822	2,706	3,520
	l/s	2.7	10.5	21.1	31.3	40.7
Abstruction And Treatment Loses(Sw)	%	7%	7%	7%	7%	7%
Max.Day Demand For Raw Water	M^3/d					3,767
	l/s	2.8	11.3	22.6	33.5	43.6

2.10.13 Peak Hour Water Demand

Peak hour demand is meant for peak demand in some hours within a day particularly during maximum day consumptions. It occurs particularly when all the water taps are opened at a particular rush hour. Such an event is likely to happen during morning hours when most people use water for bathing, washing utensils and cooking. Moreover, it could also occur at the end of the day when people need water for the same purpose after working hours. The peak hour water demand is greatly influenced by the size of the town, number of beneficiary population and social activity pattern. The ratio of the peak hour demand to the average day demand is called peak hour factor. A peak hour factor of 1.9 on daily average values has been used for Gundo Meskel town based on the stated factors and design criteria set by MoWR for urban water supplies in January, 2006. (*Design_criterea_FDRE_Minstry of Water Resources_07 June 2007_Zelalem)*

Table 2.20: Summary of peak hour water demands

Description	Unit	Year				
		2011	**2013**	**2018**	**2023**	**2028**
Avg Day Demand	M^3/d	191	760	1,519	2,255	2,934
	l/s	2.2	8.8	17.6	26.1	34.0
Maximum Day Factor		1.2	1.2	1.2	1.2	1.2
Maximum Day Demand	M^3/d	230	911	1,822	2,706	3,520
	l/s	2.7	10.5	21.1	31.3	40.7
Peak Hour Factor		2	1.9	1.9	1.9	1.9
Peak Hour Demand	M^3/d	382.8	1443.2	2885.3	4285.0	5573.7
	l/s	4.4	16.7	33.3	49.6	64.5

2.10.14 Summary of Water Demand Assessment

Based on above different types of water demands and demand variations, the following table illustrates the summary of the projected water demand for Gundo Meskel town for the design horizon.

Table 2.21: Summary of water demand for Gundo Meskel town

Description	Unit	Year
		2028
Avg Day Demand	M^3/d	2,934
	l/s	34.0
Maximum Day Factor		1.20
Maximum Day Demand	M^3/d	3,520
	l/s	40.7
Peak Hour Factor		1.9

Description	Unit	Year
		2028
Peak Hour Demand	M^3/d	5573.7
	l/s	64.5
Abstruction And Treatment Loses(Sw)	%	7%
Max.Day Demand For Row Water	M^3/d	3,767
	l/s	43.6

2.11 Water Source

2.11.1 Groundwater Discharge

Springs are the main form of groundwater discharge around the study area. For instance Hidha Dera(20l/s),and Shenkora(>35l/s) springs are major spring of water selected after intensive hydrogeological study.(*Gundo meskel town water supply detail design,2013)*

Table 2.22: Location of springs

No.	Springs	Location		Altitude(m.a.s.l)	Estimated yield(l/s)	Aquifer
		Easting	Northing			
1	Hidha dera	473475	1127468	1775	20	limestone
2	Shankora	474134	1126064	1716	>35	limestone

2.11.2 Water Quality

During water supply study for Gundo Meskel town, water samples have been collected from two springs i.e. one emerging from basaltic aquifer and the other from limestone aquifer to determine potability. Table 2.23 depict physiochemical concentrations/values of springs

Table 2.23: Physiochemical Concentration of water samples

Chemical description	Limestone aquifer water chemical concentration(mg/l)	Basaltic aquifer water chemical concentration(mg/l)	WHO maximum allowable concentration(mg/l)
Tubidity(NTU)	Nil	Nil	5
Total desolved105 ^{0}C	612	148	1000
Ammonia	1.01	0.23	
Sodium	24	6	200
Total hardness(mg/l,$Caco_3$)	494	119.7	500
Calcium	183.16	38	200
Magnesium	8.66	5.93	150
Total iron	Trace	Trace	0.3
Manganese	-	-	0.1
Fluoride	0.68	0.58	1.5
Chloride	12.74	2.73	250
Nitrate	13.27	14.43	45
Sulphate	209.44	12.76	400

The above table shows that all chemical components and physical appearance are below WHO maximum allowable concentration. Therefore, water from both aquifers is chemically as well as physically potable.

3. METHODOLOGY

3.1. Design of Water Supply Units

Design of water supply system requires provision of water source that has adequate capacity to meet the demand reliably. In order to provide efficient water supply system, water source should be reliable both from quantity and quality point of view. Poor quality water may result in one or more of the following causes.

- It affects the health of the society and hence productivity.
- It affects the hydraulic and operational characteristics of pipes, fittings, valves and pumping stations imposing an additional operational and running cost.
- It also affect the overall national economy of the country as problems like encrustation of pipes would result in a total blockage of the water supply system enforcing the government to replace part or all of the system with an additional investment costs before reaching design period.

The water may be obtained from surface or groundwater sources by expansion of existing systems. The selection of a source of supply will be based on water availability, adequacy, quality, cost of development and operation, and the expected life of the project to be served. Therefore, the water source that have sufficient capacity to meet the maximum anticipated demand for water under all conditions during the period of its useful life and capable of supplying water of the best quality economically available from the source and reliability of abstraction and recharge; are considered in the water source selection. All public water systems shall provide an adequate quantity and quality of water in a reliable manner at all times consistent with the standard requirements. Reliability applies to expectations of consumers in obtaining sufficient water, at an acceptable pressure. Therefore, reliability often differs based on customer viewpoints about an appropriate level of service. Consumers expect their water pressure to be adequate for routine uses. From a public health perspective, low pressure creates opportunities for backflow or seepage that could allow contaminants to enter drinking water. High pressure may lead to excessive leakage or failure of system facilities. State public drinking water system rules largely focus on safety and reliability (*Design_criterea_FDRE_Minstry of Water Resources_07 June 2007_Zelalem).* A reliable water system is designed and then operated

to meet the needs and expectations of consumers at all times. The two elements affecting the adequacy of a water system's reliability are:

Source Reliability:

Source reliability depends on the availability of water to meet consumer demands in a given period. Under drought conditions, line breaks, unscheduled power outages or other unusual circumstances, water systems may need to limit consumer water use. Consumer acceptance of the extent of the limitation during such periods can be expected to vary.

Climatic changes also affect groundwater source reliability. However, the effect may not be as rapid or as great. Groundwater source reliability relates more to the estimated sustainable yield of an aquifer. Pumping tests and hydro-geological analysis to determine the sustainable yield of an aquifer. The extent of the analysis usually relates to the size of the utility and its willingness to expend resources to gain the necessary data.

Facility Reliability**:**

Facility reliability depends on the ability of water system facilities, such as pumps, storage tanks, and pipelines, to deliver adequate quantities of water over specified timeframes. The frequency and duration of service interruptions and the cost required to minimize them, affect consumer expectations. Consumer expectations often drive decisions on improvements that provide higher levels of reliability for a water supply system. Gundo Meskel town water supply system design considered events limiting to water availability and weigh the higher cost of gaining added reliability against the costs associated with interruptions of service.

In water supply system multiple sources of supply provide increased reliability. The water system can still provide some service if a source fails or is taken off line. Different power grids can serve multiple sources making the water system less vulnerable to disruption due to localized power outages. Thus, we have considered provision of different sources to minimize or avoid interruptions beyond acceptable norms.

In general, the proposed water supply system assimilating the above reliability requirements; gets its water source from existing and proposed springs and existing boreholes to be developed. The water from the proposed springs will be collected to the proposed service reservoir located

at hill near to Georges church 250m from the existing 50m3 mention compound reservoir from where distribution into the town takes place by gravity.

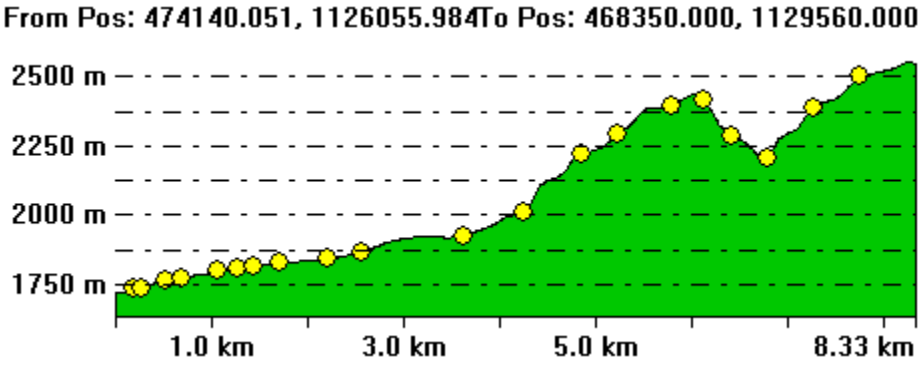

Figure 3.1: Old access road and transmission main from sources (springs) to service reservoir

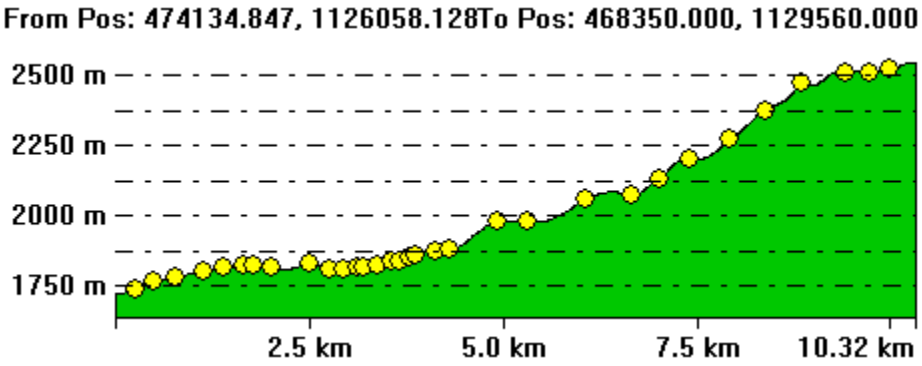

Figure 3.2: New transmission main from sources (springs) to service reservoir

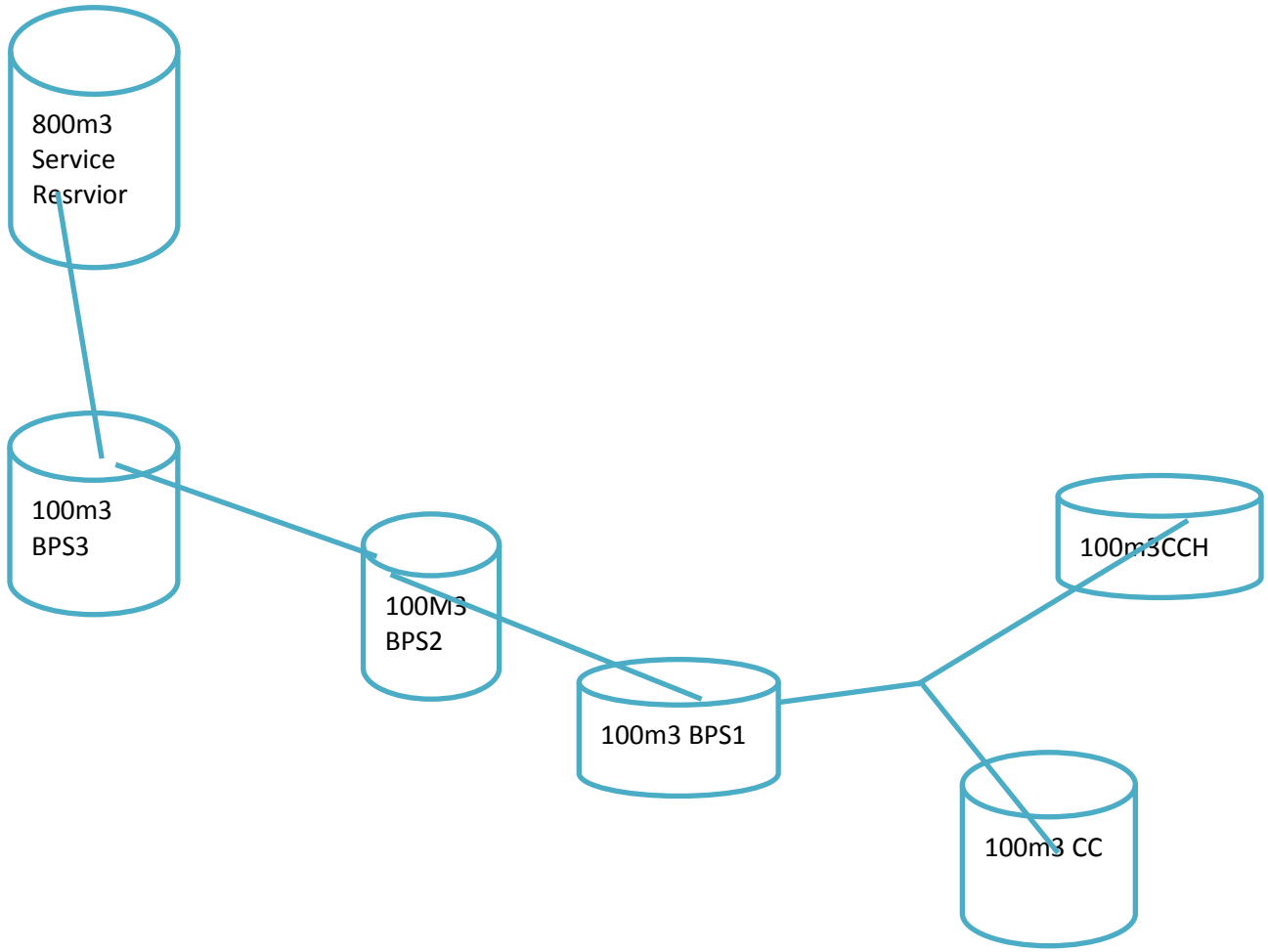

Figure 3.3: The schematic layout of the proposed water supply system and its major facilities

The assessments of the design qualities of transmission main line and access road of the Gundo meskel water supply project were made on the following steps:

1. The detail design and the Bill of quantities of the access road and transmission line is assessed at office
2. The selected route of access road and transmission main line are exhaustively studied and decided that the access road is so costly that the funding body do not afford the required cost for access road
3. An alternative route studied with reasonable cost of access road and transmission main line

3.2 Engineering Design of Pipe Lines

Selection of Pipe Materials:

Pipes commonly used for water supply projects are Ductile Iron (DCI), steel, uPVC, High Density Polyethylene (HDP) and Galvanized Iron (GI). The choice of pipe material is dependent on the following factors:

- Chemical nature of soil
- Chemical nature of water
- Comparative cost of alternatives pipes
- Weather conditions of the area
- Geologic formation of the pipe route
- Expected pressure in the pipeline

The following pipeline materials will be normally selected:

- *Metal pipes (DCI/Steel):* will be laid where exposed above the ground and for special sections such as drain/stream crossings and/or other cases. The choice between DCI and Steel will be based on opportunity cost of the pipes and convenience of handling and pipeline formation.
- *Large diameter pipes* (say, DN 400 mm and above) could be of metal (steel or DCI) depending on the opportunity cost of relevant pipes fabricated from the various materials.
- C. *uPVC and/or HDPE* for the distribution system, with typical pipes diameters of DN 400 to 50 mm.
- D. ***GI*** for service pipes of DN 2" to ¾" (50 mm to 20 mm).
- Alignment and Lying Of Pipelines

The following considerations will govern the alignment of pipelines within the supply area:

- Transmission mains will follow the shortest route between the headwork and the supply area, allowing for deviations where necessitated by topographical conditions.
- Wherever possible, pipelines will be laid at road sides and verges of footpaths, pavements or green strips. Pipes to be laid along roads will be located at a minimum distance of 900 mm outside from the edge of the road or the roadside drain.
- Distribution system pipelines forming part of the main grid will follow the existing or planned roads, while observing the necessary requirements for hydraulic efficiency and economy.

- D. Undesirable effects resulting from proximity of two metallic pipelines will be considered when routing new mains.

Laying depth of pipelines will be subject to the following criteria:

- Depth of mains below ground will take into consideration ease of maintenance, avoidance of excessive earth pressure and protection from live load due to traffic.
- Mains laid in trenches will have a minimum cover of 1.0 m for pipes of DN 400 mm and smaller, and 1.20 m for pipes of DN 400 mm and larger.
- Mains laid under carriageways or road verges will have a minimum cover of 1.20 m.
- The depth of cover will be increased as may be required where the ground level is to be changed in future for the construction of a road, where an increased depth is needed to maintain a minimum slope in the pipelines, where this will eliminate the need for an air valve, or where other special requirements call for greater depth. (*Design_criterea_FDRE_Minstry of Water Resources_07 June 2007_Zelalem).*

A minimum distance of 1.00 m will be maintained from fences and buildings to the verge of the trench for pipe laying. Where this cannot be maintained, special arrangement will be made on ad-hoc basis

Coordination with Other Utilities

In the absence of records on existing underground utilities and structures, the following procedure will be adopted, to be coordinated by Contractor during construction

- Collection of relevant information prior to preparation of construction drawings.
- Coordination with the concerned authorities prior to commencement of construction.
- Continuous coordination with the concerned authorities during construction.

➢ Underground Cables

- Mains running in parallel with underground cables will be located at a minimum distance of 900 mm away from the cable.
- Mains crossing underground cables will generally be laid at a minimum depth of 900 mm below such cables.

➢ Overhead Lines

- Mains running in parallel with or near overhead lines will have a clearance of at least 1.5 m between the base of poles and the wall of the pipe trench.
- The position of the pipeline relative to overhead lines will allow easy access for maintenance and repair
- Coordination with and Crossing of Drains, Sewers, etc.
- Whenever a main runs parallel to a drain or sewer, a minimum distance of 1.5 m will be provided between the adjacent walls of the two trenches.
- Pipes to be laid along open drains will be laid at a distance of at least 900 mm from the nearest side of the drain.
- A pipeline located above a drain, sewer, culvert, etc., will have the following minimum vertical clearances:
- 300 mm for pipe sewers, culverts, etc.
- 600 mm above maximum water level of open drains, channel, stream, etc.
- Whenever a main crosses in the form of an inverted siphon under the drain, sewer, pipe or culvert, it will be protected by a concrete surround which will extend at least 4.00 m at either side of the crossing. In addition, an impermeable layer will be formed above the water supply pipeline, such as 600 mm of compacted clay (if available) or similar.
- Where over-crossing of pipeline may occur, the exposed pipeline section will be of steel.
    - Pipeline Accessories
    - *Isolating Valves*
    - Spacing of Valves
- Isolating valves on mains will be installed at intervals of about 1.5 km, their spacing being dictated also by such factors as washout requirements, connection to consumers, connections to other mains, etc.
- Wherever a secondary main runs alongside a tertiary main, isolating valves on the secondary main will be installed at intervals of not more than 0.5 km, this being necessary to reduce the number of consumers affected by any failure in the artery. Other factors governing the spacing of valves on arteries will be washout requirements, connection to consumers, connection to other arteries or consumer mains, crossing of streams, roads, etc.

- Isolating valves on consumer pipelines will be provided at every branch connection, every street junction, and where indicated by special requirements.
- Number of Valves
- The number of isolating valves to be installed in an adequately looped grid at every intersection of secondary, tertiary or consumer mains will be n–1, where n is the number of arms at the intersection.
- One isolating valve should be provided at every one of the following points:
- Interconnecting pipe.
- Bypass.
- Hydrant connection.
- Washout.
- Air valve.
- Consumer connection.

➢ Size of Valves

- Isolating valves on mains of DN 450 mm and smaller will be of the same size as the relevant main.
- Isolating valves on mains of DN 500 mm and larger may be of a smaller diameter than the respective mains as a means of cost economy and reduced stock range. Suitable sizes of isolating valves will be as follows:
- On mains of DN 450 to 500 mm: DN 450 mm valves.
- On mains > DN 600 mm: (DN – 100 mm) valves.
- Isolating valves installed in branches for air valves, hydrants, washouts and bypasses will be of the same size as the respective branch pipes.

➢ Air Valves

Air vents (air valves) for ingress and release of air will generally be provided at the highest point of mains DN 350 mm and above (or on mains of smaller size if required) or on the downstream side near isolating valves.

Double orifice kinetic type air valve will usually be selected for installation in pipelines. All air vents will be assembled with isolating valves of the same size. The flanged end of air valves and of isolating valves shall be as per BS. The sizes of air valves to be installed on mains are to be as

shown in table below.(Design_criterea_FDRE_Minstry of Water Resources_07 June 2007_Zelalem)

Table 3.1: Sizes of air valves to be installed on mains

Main Diameter	**Air Valve Diameter**
Up to 450mm	80mm
500-600mm	100mm
650-900mm	150mm
1000-1200mm	2x100mm

Washouts and Hydrants

Washouts will be located at the lowest points of transfer pipelines and transfer/distribution mains, near drains, streams, etc., wherever suitable.

Drain pipes discharging to the drainage or sewerage ditch will be provided with a flap check valve installed on its end. Washout valves to be installed on mains are to be as shown in table below.

Table 3.2: Sizes of Washout Valves to Be Installed On Mains

Main Diameter	**Washout Valve Diameter**
Up to 450mm	80mm
500-600mm	100mm
700-900mm	150mm
1000-1200mm	200mm

Pressure Regulating Facilities

Excessive pressure will be relieved in appropriate manner. As the case is, it could be obtained, e.g. in the following manners:

- Mechanical device (pressure relief/reducing valve).
- Orifice (for transient flows).
- Pressure breaking tanks.
- Fittings
- Pipeline fittings (such as bends, tees, etc.) will be as follows:

- To be appropriate for the pipeline configuration. Normally fittings will be of Cast Iron, GS, DCI, or of uPVC where such lines are installed, similar in size and class to the pipelines will be installed.
- Wherever fittings for assembling steel pipes will be required, they are to have the same design strength as that of the pipe.
- Pipeline Appurtenant Structures
- Valve Chamber
- Concrete manholes or chambers are designed for each valve location for protection and to provide easy access for different purposes.
- Thrust Blocks
- Whenever the pipeline changes direction horizontally or vertically or changes in size; concrete thrust blocks are designed to resist the thrust force in the piping system.
- Pipe Support
- Concrete supports for pipes are designed whenever the pipe is laid above ground surface and also in situations where the foundation formations are not good.
- Lateral transverse anchors are designed for conditions where pipe is laid in steep slopes

4. RESULTS AND DISCUSSIONS

4.1. Results of the study

4.1.1. Access road study results

The proposed access road was studied and the following results were obtained:

Table 4.1: Access Road Assessment

No.	Earth work	unit	Old design qty	New design qty	Unit rate(ETB)
1	Site clearing	M2	70,000	76,580	15
2	Excavation in common soil	M3	9,750	36,546	50
3	Excavation in soft rock	M3	39,000	256,546.28	50
4	Excavation in hard rock	M3	9,360	293,092.27	150
5	Excavation up to subgrade of the road	M3	12,000	0	50

Depending on the result on the above table we can understand that excavation work (cut) in the new design will be **586,184.56 m^3,** which was only **70,000 m^3** in the agreement (old) design. As we can observe on the above result the total earth work quantity became about (10) folds of the agreement quantity and the cost of the earth work will also vary accordingly! I.e. According to the above unit rate the cost of the access road will be increased to more than **87,927,681.50ETB.**

However, the original cost in the agreement document was **9,192,363.00** ETB and it will be about (10) times in the new access road design!

However, this much variation cost in the access road is not tolerable(feasible) for the access road of water supply**.so** new route of transmission main which will maintain the old cost of the access road and safely deliver water to the reservoir is selected and studied. The summery of the whole results of the project cost is shown in the following table.

4.1.2. Transmission Study Results

Table 4.2: Summary of costs of Gundo Meskel Town Water Supply Project

SUMMARY OF GUNDO MESKEL TOWN WATER SUPPLY PROJECT												
I. No	**Description**	**Unit**	**Contract Agreement**			**Omitted**		**Added**		**Revised Agreement**		**Remark**
			QTY	**Unit Rate(Birr)**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	
1	General Items	LS	1.00	858,000.00	858,000.00					1.00	858,000.00	Orginal Contract
2	**Transmission main civil works**	**LS**	**1.00**	**323,480.00**	**323,480.00**	**1.00**	**323,480.00**	**1.00**	**6,624,810.00**	**1.00**	**6,624,810.00**	**Revised**
3	Distribution system civil works	LS	1.00	9,033,358.00	9,033,358.00					1.00	9,033,358.00	Orginal Contract
4	Storage Reservoir civil works 800m3	No	1.00	1,927,963.00	1,927,963.00					1.00	1,927,963.00	Orginal Contract

SUMMARY OF GUNDO MESKEL TOWN WATER SUPPLY PROJECT												
I. No	**Description**	**Unit**	**Contract Agreement**			**Omitted**		**Added**		**Revised Agreement**		**Remark**
			QTY	**Unit Rate(Birr)**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	
5	Collector and Transfer Reservior Civil Works 100m3	No	3.00	666,373.00	1,999,119.00					3.00	1,999,119.00	Orginal Contract
6	Construction of Public Taps	No	10.00	52,730.00	527,300.00					10.00	527,300.00	Orginal Contract (Arthmetic Error)
7	**Construction of Generator and Operator Houses**	**No**						**5.00**	**2,308,023.80**	**5.00**	**2,308,023.80**	**New Structure**
8	Construction of Pump House at spring sources	No	3.00	1,151,205.36	3,453,616.08					3.00	3,453,616.08	Orginal Contract

SUMMARY OF GUNDO MESKEL TOWN WATER SUPPLY PROJECT												
I. No	**Description**	**Unit**	**Contract Agreement**			**Omitted**		**Added**		**Revised Agreement**		**Remark**
			QTY	**Unit Rate(Birr)**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	
9	Construction of Pump House at collector and booster pumping stations	No	3.00	669,940.00	2,009,820.00					3.00	2,009,820.00	Orginal Contract
10	Construction of Chlorination House and Dosing Chamber	No	1.00	176,088.00	176,088.00					1.00	176,088.00	Orginal Contract
11	Construction of Administration Building	No	1.00	722,102.79	722,102.79					1.00	722,102.79	Orginal Contract
12	Construction of Guard Houses	No	4.00	139,896.00	559,584.00					1.00	559,584.00	Orginal Contract
13	Access Road Construction	Ls	1.00	9,192,363.00	9,192,363.00					1.00	9,192,363.00	Orginal Contract

SUMMARY OF GUNDO MESKEL TOWN WATER SUPPLY PROJECT												
I. No	**Description**	**Unit**	**Contract Agreement**			**Omitted**		**Added**		**Revised Agreement**		**Remark**
			QTY	**Unit Rate(Birr)**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	
14	**Construction of Retaining Wall**	**No**			**-**			**2.00**	**2,075,917.40**	**2.00**	**2,075,917.40**	**New Structure**
15	Installation of pump and Generator	Ls	1.00	30,000.00	30,000.00					1.00	30,000.00	Orginal Contract
16	Transportation of pump and Generator	Ls	1.00	15,000.00	15,000.00					1.00	15,000.00	Orginal Contract
17	Transportation of Pipes and fittings	Ls	1.00	106,000.00	106,000.00					1.00	106,000.00	Orginal Contract
18	Sub Total for Civil Works				30,933,793.87		323,480.00		11,008,751.20		41,619,065.07	
19	Rebate (10%)				3,093,379.3		32,348.00		1,100,875.		4,161,906.	

SUMMARY OF GUNDO MESKEL TOWN WATER SUPPLY PROJECT												
I. No	**Description**	**Unit**	**Contract Agreement**			**Omitted**		**Added**		**Revised Agreement**		**Remark**
			QTY	**Unit Rate(Birr)**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	**QTY**	**Amount(Birr)**	
					9				12		51	
20	After Rebate				27,840,414.48		291,132.00		9,907,876.08		37,457,158.56	
21	VAT (15%)				4,176,062.17		43,669.80		1,486,181.41		5,618,573.78	
22	Grand Total With VAT				32,016,476.66		334,801.80		11,394,057.49		43,075,732.35	

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Generally this assessment shows that poor quality of rout selection of transmission main and access road of water supply project will lead to major cost escalation and delayance of the construction of the water supply projects .in addition to this the poor route selection of transmission and access road also indirect impacts on another structures construction because without access to the structures proposed place we can't built the necessary structures with required qualities.

5.2 Recommendations

In order to build water supply projects with a scheduled timeframe and the allocated budgets, economic design of the whole projects components are a must and that of transmission main and access road is particular for the water supply projects.

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